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Dual beam laser keyhole welding of steel/aluminum lapped joints

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Abstract

Laser welding of Q235 low carbon steel and 6061 aluminum (Al) alloy was carried out by using a dual beam fiber laser in keyhole welding mode in a steel-on-Al lapped configuration. The influence of processing parameters of power distribution ratios (R_s) and dual beam laser distances (d_1) on the weld shapes, microstructures of intermetallic compound (IMC) layers, microhardness and tensile resistance of the steel/Al joints was studied. Soundly welded steel/Al joints have been achieved by using dual beam laser keyhole welding at R_s=0.67 and d_1=1.5 mm. The key factor affecting welding defects is the control of the penetration depth of the welds, and good weld shape has been achieved when the penetration depth of the welds is below 700 μm. The formation of IMC phases consisted of Fe_4Al_{13}, Fe_2Al_5 and $FeAl_2$ phases is only limited to the weld/Al interface when the steel/Al joint has a relatively low penetration depth of the welds in the steel/Al joint. The maximum tensile resistance of the steel/Al alloy joints of 115.6 N/mm is obtained under the conditions of R_s=0.67 and d_1=1.5 mm. The fracture surface reveals a mixed failure occurred in the Al alloy leading to high tensile resistance of the steel/Al joints.

Keywords: Dual beam laser keyhole welding; steel/Al joint; IMC layers; Microhardness; Tensile resistance

1. Introduction

Dissimilar joining of the steel/Al joints has become increasingly significant in automotive industrial applications aiming to reduce the total weight of the vehicle (Meco et al., 2015; Chen et al., 2016). Fusion